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ABSTRACT

Coal, at one-third the cost of natural gas and one-fifth the cost of oil, is our cheapest source of energy and is also in abundant supply. Because of significant technological advances, coal-fired equipment now approaches the clean and automatic operational characteristics of gas- and oil-fired boilers. For these reasons, and because schools are eligible for loans and grants from the federal government to finance coal conversions, coal has many advantages for public schools. However, coal conversions are subject to a number of site-specific variables that should be considered. Since coal prices vary with quality, different coals should be compared on the basis of the heating value obtained per dollar. Available coal supplies should be evaluated in conjunction with the selection of stoker equipment and transportation factors. Coal price is also affected by the size of the shipment; therefore, cooperative purchases should be considered. In addition, space allocations for receiving and storing coal and arrangements for ash removal need to be made. Examples of an actual conversion and of a planned conversion illustrate the economics of coal utilization. (MLF)

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COAL UTILIZATION IN SCHOOLS: ISSUES AND ANSWERS

Robert H. Pusey

March 1, 1982

Paper presented at the Annual Meeting of the American Association of School Administrators (114th, New Orleans, LA, February 26-March 1, 1982).

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COAL UTILIZATION IN SCHOOLS: ISSUES AND ANSWERS

Since the energy crisis of 1973, significant increases in coal utilization have been projected. In fact, coal is expected to be the nation's major energy source by 1990. However, the figures in Table I show only a slight increase in coal consumption through 1981.

TABLE I

U. S. ENERGY CONSUMPTION BY ENERGY SOURCE

	1973	1981
Petroleum	47%	43%
Natural Gas	30%	28%
Coal	18%	21%
Hydroelectric	4%	4%
Nuclear	1%	4%

SOURCE: *Department of Energy, Energy Information Administration.*

This increase in coal utilization is attributed primarily to the switch from oil and gas to coal by electric utilities. Even though there have been investment and tax credit incentives for coal conversion, high capital costs, high interest rates, and environmental regulations appear to be barriers to greater commercial and industrial coal utilization. Even so, coal has proven to be a viable option for some applications, and in particular, has many advantages for public schools.

Coal is, by far, our cheapest source of energy. The data in Table II compare the costs of a million Btu's from our basic energy sources.

Coal is one-third the cost of natural gas and one-fifth the cost of oil. Even though the price of all fuels is projected to increase, coal should maintain its present competitive position.

TABLE II

U. S. ENERGY COSTS PER MILLION BTU'S

	1981 (Average)	1982 (Projected)	Percent Change
Coal* (11,500 Btu/lb)	$ 1.35	$ 1.66	23.0
Natural Gas (1030 Btu/cf)	$ 4.10	$ 5.39	31.5
Heating Oil (138,000 Btu/gal)	$ 8.84	$ 9.28	5.0
Electricity** (3,415 Btu/kwh)	$17.31	$18.27	5.5

* Rate for Utilities
** Rate for Residential Consumers

SOURCE: Energy Information Administration.

Coal is also in abundant supply, and as illustrated in Figure 1, on page 3, coal deposits are in close proximity to much of the nation. Reserves projected by the U. S. Bureau of Mines for the Eastern and Central Regions are in excess of 100 billion tons each, and the reserves for the Western Region are in excess of 200 billion tons. Obviously, the risk of supply shortages of coal are far less than those of oil or natural gas.

Significant technological advances have been made in coal-fired boiler equipment in the last five years. Such innovations as increased furnace volume, overfire combustion air, electric draft regulators, and automatic soot blowers have resulted in more complete combustion, higher furnace

temperatures and, therefore, higher efficiencies. Multiple fuel and fluidized-bed boilers are available in small-scale sizes. Coal-fired equipment now approaches the clean and automatic operational characteristics of gas and oil-fired boilers. In addition, schools are eligible for loans and grants from the federal government to finance coal conversions.

Coal Fields in the Continental United States

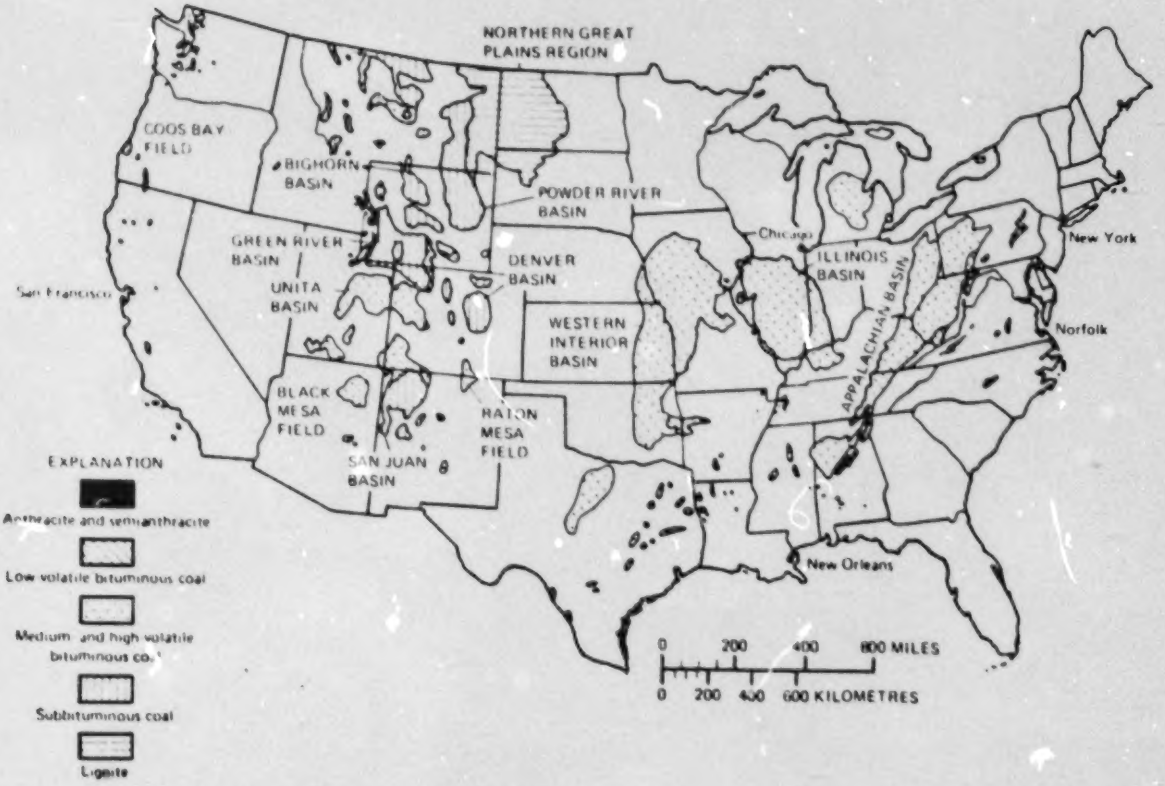

FIGURE 1

The advantages for coal are subject to considerable variation across the country. Likewise, school facilities and energy loads vary from one school to another. Therefore, coal conversions are highly dependent upon

local economics and should be evaluated on a site-specific basis. There are several common issues which should be considered in the evaluation process.

The quality of the potential coal supply is a significant factor in coal conversions. The characteristics of coal vary considerably from mine-to-mine. The properties of major importance are heating value, sulfur content, moisture content, and ash content. For most facilities, the desirable combination of these properties are high heating value and low moisture, sulfur and ash content. Coal prices vary with the quality and the coal with the lowest price may not provide the best economic value. One should compare coals on the basis of the heating value obtained per dollar and the additional capital and operating costs that may be required to use coals with high moisture, sulfur, and ash content.

Coal is found in four geological forms - anthracite, bituminous, subbituminous, and lignite. The majority of the nation's coal reserves are bituminous and are located in the Eastern and Central Regions of the country. Western coals are primarily subbituminous. Variations in coal quality are shown in Table III.

TABLE III

TYPICAL PROPERTIES OF COALS

	Heating Value	Moisture	Sulfur	Ash
Anthracite	Medium	Low	Medium	High
Bituminous	Medium/High	Low/Medium	Low/High	Low/High
Subbituminous	Low/Medium	Medium	Low	Low/Medium
Lignite	Low	High	Low	Low

Coal may be purchased in a variety of sizes such as lump, egg, nut, stoker, and many others. In every case, the size is really a range of sizes, and in all cases, will include some percentage of fines. It is necessary to select a coal size that will be compatible with stoker design. Thus, one needs to evaluate available coal supplies in conjunction with the selection of stoker equipment.

Another factor of importance, is the mode of coal transportation. Coal may be transported from the mine by rail or truck, and in a few areas, by barge. Most long-distance transport is by rail and, therefore, requires a local coal terminal or siding for unloading with subsequent delivery to the school site by truck. Rail transportation rates are cheaper per ton-mile than truck rates, but may be offset by the costs of additional handling.

The size of the coal shipment will be a factor in evaluating transportation costs. Large volume shipments are more economical, and cooperative purchases with other area schools or firms should be considered. Also, contract buying should be more economical in the long-term than spot market purchases.

One of the most important considerations of coal conversions is space. Coal-fired systems require more floor space and ceiling height than oil or gas systems. Adequate space must be provided for receiving and storing coal shipments. The area needed is dependent upon the frequency and volume of shipments as well as the storage capacity. Likewise, the relative elevations of the storage area and boiler will affect the selection of coal conveying equipment. Provisions must also be made for ash removal.

Typically, small scale coal-fired systems are fed by stokers which are positioned beneath the furnace. Greater vertical space is required for these units. Consideration should be given to space for and placement of control panels. In some cases, space will also be required for pollution control equipment.

The major environmental concerns of coal combustion are particulate and sulfur emissions and ash disposal. The burning of low sulfur, low ash coal in properly designed facilities under carefully controlled conditions should eliminate the need for pollution control equipment. However, environmental standards vary significantly across the nation, and local air pollution agencies should be contacted to determine area requirements.

Obviously, the most important issue in evaluating coal conversions is that of economics. A careful estimate of all capital, installation, and operating costs associated with the conversion should be compared to the savings to be realized from fuel costs. Many techniques are available for this comparison. A simple payback analysis is usually sufficient for preliminary coal conversion feasibility studies. However, a detailed, life-cycle cost analysis may be required to reach a final decision.

Other issues such as maintenance, replacement parts, manpower requirements, etc., should be considered in coal conversion studies. These issues are normally of lesser importance and are difficult to analyze without addressing specific site conditions.

As a general rule, the reconversion to coal of boilers originally designed to burn coal, but later converted to oil or gas, is a highly

profitable venture with a short payback period. The installation of new coal-fired boilers to satisfy increased demands or serve new facilities should also be economically feasible, but require a longer payback period. The conversion of boilers originally designed to burn oil or gas will be very costly and not likely to have an acceptable payback period. The following examples of actual or planned conversions illustrate the economics of coal utilization.

EXAMPLE I

COMPLETED COAL CONVERSIONS IN A VIRGINIA SCHOOL SYSTEM

Situation: 2 high schools, 2 middle schools, and 1 elementary school with boilers originally designed for coal, but converted to oil several years ago; 1980-81 fuel consumption of 174,754 gallons of No. 2 fuel oil at $1.05/gallon; 5753 degree days in 1980-81; efficiency of 85%.

Conversion: Reconvert 9 boilers to coal-firing; Kentucky coal available with heating value of 13,648 Btu/lb, 4.5% moisture content, and 0.8% sulfur content; contract for 1100 to 1400 tons of coal at $42/ton; rail transportation at $18/ton; lease of railroad siding at $100/month; local truck delivery at $6.50/ton; estimated boiler efficiency of 70%.

Heating Requirements: 174,754 x 138,000 x .85 = 20,498,644,000 Btu's.

Coal Required : $\frac{20,498,644,000 \text{ Btu}}{13648 \times 2000 \times 0.7}$ = 1073 Tons

Economics:

1981-82 budgeted oil costs :	174,754 x $1.22 =	$213,200
1981-82 projected coal costs:	1073 x $66.50 =	71,355
Projected fuel savings :		$141,845

Equipment Costs:

9 Stokers :	$101,760
New Coal Bins (2)	20,000
Installation and Accessories:	68,240
Siding Lease (4 months) :	400
Manpower (2.5 man years) :	20,000
Total Costs :	$210,400

Payback: $\frac{\$210,400}{\$141,845}$ = 1.5 Heating Season

EXAMPLE II

PROPOSED COAL CONVERSION IN A VIRGINIA HIGH SCHOOL

Situation: Three oil-fired boilers (converted from original coal-fired); 75% efficient; 4473 degree days; 1980-81 fuel consumption of 49,840 gallons of No. 2 fuel oil at $1.06/gallon.

Conversion: Convert 2 boilers back to coal; assumed heating value of coal is 12,000 Btu/lb; boiler efficiency of 70%; projected coal price is $50.50/ton.

Heating Requirements: 49,840 x 138,000 x 0.75 = 5,158,440,000 Btu's.

Coal Required : $\frac{5,158,440,000 \text{ Btu}}{12,000 \times 2000 \times 0.70}$ = 307 Tons

Economics:

1981-82 projected oil costs :	49,840 x $1.20 =	$59,808
1981-82 projected coal costs:	307 x $50.50	15,504
Projected fuel savings :		$44,304

Equipment Costs:	2 Stokers :	$ 53.500
	Ash Handling :	12,000
	Installation :	21,250
	Electric Power and Wiring :	6,000
	Other Contractual Services:	40,280
	Total Costs :	$133,030

Payback: $\frac{\$133,030}{\$\ 44,304}$ = 3 Heating Seasons